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Comparison of Injection Discomfort and Anesthetic Duration of Plain Polocaine versus Epinephrine containing Articaine and Lidocaine

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COMPARISON OF INJECTION DISCOMFORT AND ANESTHETIC DURATION OF PLAIN POLOCAINE VERSUS EPINEPHRINE CONTAINING ARTICAINE AND LIDOCAINE

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

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Abstract

COMPARISON OF INJECTION DISCOMFORT AND ANESTHETIC DURATION OF PLAIN POLOCAINE VERSUS EPINEPHRINE CONTAINING ARTICAINE AND LIDOCAINE

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Purpose: To determine possible differences in the pain level and soft tissue anesthesia duration of plain polocaine versus epinephrine-containing articaine and lidocaine during intraoral injections.

Methods: Forty-eight subjects received plain polocaine and one epinephrine-containing anesthetic. Injections were randomized according to the first injection a)left or right buccal sulcus and b)epinephrine or not. The second injections were the opposite conditions. Subjects then recorded discomfort on a VAS and the time anesthesia wore off.

Result: The second injection's pain rating was influenced by the first. This carry-over effect makes it impossible to analyze all of the data. An analysis of the first injection showed no

significant difference between the three anesthetics. The duration of anesthesia for epinephrine-containing anesthetic was significantly longer than plain polocaine.

Conclusion: This pilot study was intended to create a sample size for a pediatric population. However, due to the carry-over effect, future split-mouth studies may not be justified.

Introduction

The advent of local anesthetic heralded a new era of patient comfort in dentistry. However, it is an irony that local anesthetic injection enables painless work in the oral cavity, but also provokes high anxiety and fear in patients. Fear due to perceived discomfort from injections is considered one of the main reasons for dental anxiety.[1] Successfully administered local anesthesia allows the dentist to nurture the relationship with the patient, proceed with the appointment, and to complete the therapeutic procedure while providing a pleasant experience.

There are a number of factors that can influence the discomfort of a dental injection such as pH buffering of anesthetic solution, heating of anesthetic solution, applying pressure, controlling the speed of injection, use of appropriate needle gauge, use of relaxation techniques, use of topical anesthetic, use of aspirating syringe, and explanation of the procedure.[2] Parameters relating to materials, but independent of technique that might affect pain at delivery include the temperature and pH of the solution. Buffering the solution with sodium bicarbonate can reduce the injection discomfort.[3] However, this is not practical when prefilled dental cartridges are used. Therefore, pH-dependent factors can be influenced by the choice of anesthetic; for example plain polocaine solutions have a pH closer to physiological pH compared with those that contain epinephrine.[4] Plain local anesthetic solutions may cause less injection discomfort compared to epinephrine-containing local anesthetic.

Plain polocaine has also been found to be equivalent to other epinephrine containing local anesthetics for achieving pulpal anesthesia.[5, 6] Although epinephrine in local anesthetic solutions are beneficial in regards to duration, this could be considered a disadvantage as well.

Vasoconstriction leads to soft-tissue anesthesia that lasts several hours beyond completion of treatment.[7] This can lead to attenuated capability to speak, eat, drink, or smile. Especially in children, accidental biting of the lips, cheeks, or tongue could cause soft-tissue damage.[7] Therefore decreasing the post-operative duration of soft-tissue anesthesia could decrease this adverse effect. To reduce the incidence of such soft-tissue injury, some clinicians use 3% polocaine instead of 2% lidocaine-epinephrine.[8] One study found a statistically significant difference in the duration of soft-tissue for articaine with epinephrine (140.69±49.76 minutes) as opposed to plain polocaine (117.52±42.99 minutes).[9]

The majority of current studies on plain versus epinephrine-containing local anesthetic solution have been focused on its effect on cardiac patients.[10] Meechan and Day did a study comparing injection discomfort levels produced by two solutions on 24 subjects (ages 20 to 24) in which they found plain lidocaine produces less discomfort than lidocaine with epinephrine when administered into the maxillary premolar buccal surface. [4] However, Meechan and Day used the traditional method of injection with short needles and aspirating syringes which did not control for injection speed, pressure, or penetration depth.

An available marketed technology, The Wand (Dental Practice Systems, Herts, UK), uses a microprocessor and an electronically controlled motor to deliver the anesthetic solution through a handpiece with a needle at a constant rate and under controlled pressure. Most current studies have found no difference in the pain or anxiety experienced in the conventional and Wand group.[11] However, some concluded block anesthesia seems to be less painful when using the Wand than when using a traditional syringe.[1] Delivery of the anesthetic solution via the Wand is activated with a foot pedal and the thin, light handpiece with a needle held in a pen-like grasp

helps to avoid variation in pressure during injection of anesthetic.[1] The Wand will be used in this study to control for injection speed and pressure.

Specific Aim

The goal of this randomized, double-blind, split-mouth study is to determine whether there is a difference in the perceived pain level and soft tissue anesthesia duration of plain polocaine versus epinephrine-containing articaine and lidocaine during intraoral injection with The Wand.

Methods

This study, which modeled the study done by Meechan and Day, was a pilot study carried out on Virginia Commonwealth subjects. Adult human subjects are more able to give an accurate pain response than children[12] and the information obtained from this pilot study will be used to create an appropriate sample size for the second part of this study, the pediatric population. The study design was a double blind crossover study in which compared plain polocaine to the two most frequently used local anesthetics in pediatric dentistry, 2% lidocaine with 1:100,000 epinephrine and 4% articaine with 1:100,000 epinephrine.[13] Each subject received plain polocaine and either epinephrine-containing lidocaine or articaine in a randomized order with the Wand.

Forty-eight students (24 men, 24 women) between the ages of 22 and 32 volunteered for this pilot study after it was approved by the Institutional Review Board. Subjects over 35 years of age, on any analgesic within the previous 72 hours, with any acute/chronic systemic conditions, especially neurologic conditions, pregnant, and known allergies to drugs used in this study were excluded. Students were fully informed of the purpose of the study, their research related duties, and written consents and a health history form were completed. A power analysis from the Meechan and Day study indicated that a sample size of 24 subjects provided a 90% chance of detecting a 10-mm difference on the visual analogue scale (VAS) at the 1% level of significance. We had 48 subjects equally divided amongst the two anesthetic studies, comparing plain polocaine to epinephrine-containing lidocaine and plain polocaine to epinephrine-containing articaine.

A pack of 3% plain polocaine, 2% lidocaine containing 1:100,000 epinephrine, and 4% articaine containing 1:100,000 epinephrine were obtained (Southern Anesthesia, West Columbia, South Carolina, USA). To maintain double-blind conditions, research assistants who were not directly involved in the delivery of local anesthetic solutions removed the product identification label from each cartridge and replaced it with a color-coded sticker. The stickers had the subject number, either "1" for 1st injection or "2" for second injection, and either "L" for left or "R" for right. Therefore, the cartridges were identical except for the color-coded sticker found on each cartridge. The pH of a sample of each solution from the same batch numbers was measured on an electronic pH meter (Mettler Toledo, Columbus, Ohio, USA) to verify the manufactuers' reported pH level.

Injections were randomized according to whether the first injection was a) on the left or right buccal sulcus in the maxillary first premolar region and b) epinephrine or not. The second injection was the opposite site and used the other condition. There were four double blind randomly assigned injection sequence groups as follows for each study:

1) left side, no epinephrine
2) left side, epinephrine
3) right side, no epinephrine
4) right side, epinephrine

Subjects were randomized using a computer generated sequence to insure equal group sizes.

The same operator, who was blinded to the identity of the solutions, gave all the injections at room temperature. Through pre-trial measurements, the quantity of solution injected was 0.84 mL over 30 seconds. For reasons of simplicity, palatal or other types of injections were not included. No topical anesthetic was applied before injection because this

added an uncontrolled variable to the study. Also, some studies have shown no significant difference between the placebo and any topical anesthetic.[14] The Wand was used throughout and the 30 gauge, 1 inch needle was inserted the same depth into the injection site. To control the depth of penetration into the maxillary buccal sulcus, the Wand handpiece with a half inch needle was inserted into the barrel of an UltraSafe aspirating syringe (Safety Syringe, Carlsbad, California, USA) (no longer available) which only allows the needle of the Wand to extrude the same length of 3mm out the tip of the syringe.

Immediately after each local anesthetic administration, the subjects recorded injection discomfort on a continuous 100-mm VAS with endpoints "no pain" and "unbearable pain." The subjects received a form with the time the anesthetic was delivered and instructed to record the time soft-tissue anesthesia had worn off for both sides. Differences between solutions, left versus right sides, and first versus second order effects were analyzed using Student's paired t test modified to reflect the crossover design of the two sets of comparison groups. Differences were considered significant when $P<05$. Specifically, a repeated-measured mixed-model ANOVA was performed for each outcome (pain and time) with effects in the model to test for differences between the two sets of anesthesia pairs, accounting for differences also due to injection order and side of mouth.

After the results from the pilot study are obtained and analyzed, a similar study will be carried out on a pediatric population if the results are significant and pending approval by the Institutional Review Boards. Parents will provide written informed consent on behalf of their children and children will provide verbal assent to participate. An appropriate sample size of children between the ages of 7 and 18[15] who require restorative treatment without pulp

involvement of one or more deciduous molars per sides of the maxillary arch will be administered anesthetic injections with identical protocols developed in this pilot study.

Statistical Methods

Study subjects were randomized into four sequence groups, per study. Since this randomized, double-blind, split-mouth crossover study had multiple measures per subject, a repeated-measures mixed-model ANOVA was used to compare the VAS pain and the numbness duration across the study groups. Depending upon the outcomes measured, the ANOVA may have included effects for Study (articaine versus polocaine, lidocaine versus polocaine), sequence (Artic Polo, Polo Artic, Lido Polo, Polo Lido), side (left, right), or rater (1, 2). All analyses were performed using SAS software (version 9.3, SAS Institute Inc., Cary NC). Significance was declared at alpha=0.05.

Results

The pH of the plain polocaine solution was 6.4; the epinephrine-containing lidocaine and articaine was 4.7 and 3.6 respectively.

Overview

First, the subjects included in the study groups will be described. Followed by the analysis of the VAS pain scores in two parts. The first part will show how the second injection's pain rating was influenced by the first injection. This carry-over effect in the crossover study makes it impossible to analyze all of the data using conventional crossover analysis. In the second part, an analysis of the results from the first injection will be shown. Lastly, the numbness duration will be analyzed.

Description of subjects

48 subjects were screened for inclusion in the study, met the inclusion criteria, and consented to participate in the study. The average age of the subjects was 26 (SD = 2.35, range = 22 to 32) with each gender represented at 50%. There were equal numbers of subjects assigned to the 2 study groups. However, due to operator error resulting in two subjects being assigned to incorrect groups, 23 subjects were in the articaine versus polocaine study and 25 were in the lidocaine versus polocaine study. All subjects received both injected anesthetics in a random order and a random side. The number of subjects in each ordering group is shown in Table 1. For example, there were 7 subjects who first received an articaine injection on the left side, and therefore received the subsequent polocaine injection, on the right side. As may be

seen, there were approximately equal numbers of injection orders in each study. Since the study assignment and order were randomly assigned, there should have been no differences depending upon the sex or age of the subjects and the findings in this study were in agreement ($P > 0.4$).

Analysis of pain VAS

The primary outcome was the rating of pain, which was measured by two observers. There was never more than one unit of difference between the two observers. The first observer reported slightly higher pain scores (mean difference = 0.08, SE = 0.032) but the difference was not significant (paired t-test $P = 0.0579$).

The goal of this randomized, double-blind, split-mouth study was to determine if there was a difference in the perceived pain level and soft tissue anesthesia duration of plain polocaine versus epinephrine-containing articaine and lidocaine during intraoral injection with The Wand. Table 2 shows the results for each study. In a crossover design, each subject received both interventions and therefore served as their own control. Subjects are randomized to one of two sequences; in the articaine versus polocaine study, 12 subjects received the articaine injection first and then the polocaine injection (sequence = "Artic Polo") and 11 subjects received the polocaine injection first and then the articaine injection (sequence = "Polo Artic"). This design works as long as there is no order effects; that is, when the order of the injections does not affect the pain rating. As seen in Table 2, this does not seem to be the case. When receiving articaine first, the difference between the articaine pain minus the polocaine pain was –1.00. The difference between the articaine pain minus the polocaine pain was +3.41 when receiving polocaine first. When receiving lidocaine first, the difference between the lidocaine pain minus the polocaine pain was –6.69. The difference between the lidocaine pain minus the polocaine pain was +6.38 when receiving polocaine first. This "carry-over effect" confounds the

estimation of the effect of the injection. That is, it was impossible to use all the data to determine whether there was a difference in the perceived pain level of plain polocaine versus epinephrine-containing articaine and lidocaine.

In the analyses that follow, we will test for a significant carry-over effect and, if it is present, the best that can be done is to analyze only the first injection. The parallel coordinate plots of Figure 1 show one line for each subject and a red line for the average across all subjects in that group. Figure 1(a) and 1(b) are those in the articaine versus polocaine study. The plot in figure 1(a) shows the average trending weakly upward and the plot in figure 1(b) shows the average trending weakly downward. In figure 1(c) and 1(d), the subjects in the lidocaine versus polocaine study are shown. The plot in figure 1(c) shows almost all the subjects sloped upward and in the figure 1(d) plot almost all the subjects sloped downward. If there had been no carry-over effect, the lines should have trended in the same direction. That is, if order did not matter, the slope of the lines representing the effect of epinephrine versus no epinephrine would have been similar. They were not.

The VAS pain levels were analyzed using a repeated-measures mixed-model ANOVA with the following factors: study (articaine versus polocaine, lidocaine versus polocaine), sequence (Artic Polo, Polo Artic, Lido Polo, Polo Lido), side (left, right), and rater (1, 2). The results shown in Table 3 showed there was a significant carry-over effect ($P < .0001$). This is seen in the interaction test, "Inject*Sequence(Study)"; this test asked if the effect of the two injections were the same across the two sequences used within each study. Also evident if the data in Table 2, the difference between the injection containing epinephrine and that without epinephrine was different depending upon which injection came first.

The averages for each group's VAS pain score are given in Table 4 and include 95% confidence intervals and P-values comparing the two injections within each sequence. For the articaine versus polocaine subjects there was no difference between the two injection order groups, "Artic Polo" sequence (P = 0.554) and "Polo Artic" sequence (P = 0.099). However, the signs for the differences were reversed in the two sequences, an indication of a carry-over effect. See Figure 2 for an illustration of this reversal. For the lidocaine versus polocaine subjects, there were similar results as in the articaine versus polocaine subjects with respect to the signs indicating a carry-over effect. Again, the signs for the differences in the two sequences were opposite, which indicates a carry-over effect. With clear indication that the second pain rating is influenced by the first, the second injection data cannot be used to answer the aim of the study. The best that can be done is to analyze only the first injection's data.

A repeated-measures mixed-model ANOVA was run with the following factors considered: Injection (articaine, lidocaine, polocaine), rater (1,2), and side (L, R). Table 5 shows the results, and there was no significant difference between the three injections (P = 0.658).

The average VAS pain values for each of the groupings are shown in Table 6. The pain levels are comparable and in the range from 12 to 17mm.

A repeated-measures mixed-model ANOVA was run with the following factors considered: Study (articaine versus polocaine, lidocaine versus polocaine), injection (articaine, lidocaine, polocaine), rater (1,2), side (L, R), sex (male, female), age (years). Table 7 shows the results, and there was no significant difference between the three injections (P > 0.9). There was also no left versus right side difference, no significant difference between the raters, no relationship with age, no male versus female difference, and no difference between the subjects in the two studies.

Analysis of Numbness Duration

As a secondary aim, the study sought to compare the duration of numbness in the groups. The minutes were analyzed using a repeated-measures mixed-model ANOVA with the following factors: study (articaine versus polocaine, lidocaine versus polocaine), sequence (Artic Polo, Polo Artic, Lido Polo, Polo Lido), and side (left, right). The results are shown in 8. In this case, the results are clear. The differences between the epinephrine injection and the non-epinephrine injection are similar across the two sequences ($P = 0.427$). The primary finding was a significant difference between the numbness duration of the epinephrine injections and the non-epinephrine injections ($P < .0001$).

The average duration of numbness in all the study groups is shown in Table 8. As may be seen from the table, in all cases the articaine or lidocaine injections had longer duration than did the polocaine injections.

Since the sequence/order of injections had no effect on numbness, the results may be collapsed across these groups. These averages are shown in Table 9. The effects of polocaine dissipated approximately wore off approximately an hour earlier.

Discussion

A number of factors can be used to reduce the discomfort of a local anesthetic injection such as pH buffering of an anesthetic solution, heating of an anesthetic solution, applying pressure, controlling the speed of injection, use of appropriate needle gauge, relaxation techniques, topical anesthetic, aspirating syringe, and an explanation of the procedure.[2] However, there is little evidence in the literature that the various methods proposed are dependable.

In addition to the techniques listed above, pH of the solution which is influenced by the choice of anesthetic has been proposed as being significant in relation to injection pain. There is evidence in the medical literature that pH influences injection discomfort.[16] However, there is little evidence in the dental literature that this occurs with intraoral anesthesia. Meechan noted that the injection into the maxillary premolar buccal sulcus of lidocaine with epinephrine (lower pH) produced more discomfort than plain lidocaine[4]. On the other hand, Wahl[17] reported no difference in injection discomfort during maxillary buccal infiltrations and inferior alveolar nerve blocks with prilocaine plain versus lidocaine with 1:100,000 epinephrine.

This study was designed to determine the influence of different commercially available local anesthetic solutions on injection discomfort in the mouth. All other parameters were standardized. The plain solution had a pH closer to physiological than the epinephrine-containing anesthetics. The results of this investigation differ with those of Meechan[4]. This may be due to the different rate of injections. Meechan delivered 1.0 mL over 30 seconds whereas

0.84 mL was delivered over the same period in this study. These findings are in agreement with those of Wahl's study[17], which analyzed 334 injections in 310 patients using topical anesthetic prior to administration of anesthetics. In this split-mouth pilot study, it was elected not to use topical anesthetic to eliminate variations in the amount used and possible attenuation of pain.

The power analysis in Meechan's study dictated that a sample size of 24 subjects provided a 90% chance of detecting a 10-mm difference in the VAS at the 1% level[4]. However, the carry-over effect eliminated the subjects being their own control for this split-mouth study. Therefore, the number of subjects in this study (24 per study) may be too small to allow for definitive conclusions.

In addition, it is apparent that injection discomfort varies in different areas of the mouth. The maxillary buccal sulcus in the premolar area is usually considered a relatively comfortable region for local anesthetic administration. Data was entered into the Meechan[4] study only if one or both scores on the pair were at least 30mm on the VAS because the sensitivity of the acute pain trials is dependent on the production of moderate paint. This resulted in 50% of the volunteers who did not achieve an injection discomfort score that merited inclusion in the study. If the same VAS criteria were used, 83% of subjects would have been excluded. Low VAS scores in this study, relative to Meechan's study, may be due to the Wand delivering a more comfortable injection method. Since we did not include palatal injections in our study, there may be a difference in the pain response between anesthetics for this injection site.

Although the results of this investigation suggest no decrease in discomfort for the use of plain polocaine solutions, this local anesthetic may be preferred for restoratives on the pediatric patients. Epinephrine causes soft-tissue anesthesia that may last hours beyond completion of

treatment.[7] In this study, we found a statistically significant difference between duration of soft tissue numbness of plain anesthetic versus epinephrine-containing anesthetic. Polocaine averaged 87 minutes, articaine with epinephrine averaged 150 minutes, and lidocaine with epinephrine averaged 152 minutes. This prolonged numbness can lead to accidental lip, cheek, or tongue biting in children.[7] To reduce the incidence of such soft-tissue injury, some clinicians use 3% polocaine instead of 2% lidocaine-epinephrine.[8] Although this study does not investigate pulpal anesthesia, 3% polocaine has been found to be equivalent to other anesthetic solutions for achieving pulpal anesthesia and inferior alveolar nerve blocks.[6]

This present study also showed a statistically significant order effect in relation to the maxillary infiltration injections. The fact that the order of injection affects the injection pain confirms results of other investigations on intraoral injection discomfort. For example, Martin[18] found that patients who received bilateral buccal injections in the maxillary premolar region reported the second injection to be significantly more uncomfortable than the first administration. This implies the best chance of providing comfortable anesthetic delivery is at the first injection. Thus, choosing an intraoral area where such possibility exists as the first site of injection is supported. If additional administrations can be delivered into areas where the initial anesthetic has spread, the overall pain experience for the patient might be reduced.

Conclusion

- There was no significant difference in the perceived pain on injection with plain polocaine versus epinephrine containing anesthetics.
- Under the methods of this study, regardless of which anesthetic administered, subjects usually experienced only mild pain on injection.
- Duration of soft tissue anesthesia for epinephrine-containing anesthetic was significantly longer than plain polocaine which may increase the chances for soft tissue trauma.
- Second injection was significantly more painful than the first injection.
- Due to the carry-over effect, future split-mouth studies may not be justified.
- Further study of the role of pH and injection pain is warranted.

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APPENDIX

TABLES, FIGURES, AND FORMS

Table 1: Random Order of First Injection

		First injection		Second injection	
Study	N	Side	Product	Side	Product
Articaine vs Polocaine					
	7	L	Articaine	R	Polocaine
	6	L	Polocaine	R	Articaine
	5	R	Articaine	L	Polocaine
	5	R	Polocaine	L	Articaine
Lidocaine vs Polocaine					
	7	L	Lido	R	Polocaine
	6	L	Polocaine	R	Lido
	6	R	Lido	L	Polocaine
	6	R	Polocaine	L	Lido

Table 2: Summary

			Pain VAS		
Sequence	Injection	Order	n	Mean	SD
articaine vs polocaine subjects					
Artic Polo	Artic	1st	12	16.54	8.12
	Polo	2nd	12	17.54	9.96
	Artic-Polo			–1.00	
Polo Artic	Artic	2nd	11	20.27	16.25
	Polo	1st	11	16.86	14.88
	Artic-Polo			+3.41	
lidocaine vs polocaine subjects					
Lido Polo	Lido	1st	13	12.69	8.82
	Polo	2nd	13	19.38	9.88
	Lido-Polo			–6.69	
Polo Lido	Lido	2nd	12	18.50	16.37
	Polo	1st	12	12.13	7.66
	Lido-Polo			+6.38	

Abbreviations: SD=standard deviation, Artic=articaine, Polo=polocaine, Lido=lidocaine

Table 3: ANOVA results

Effect	Num DF	Den DF	F	P
Study	1	44	0.50	0.4822
Sequence	2	44	0.08	0.9259
Injection(Study)	2	138	0.32	0.7251
Rater	1	138	0.01	0.9346
Side	1	138	1.49	0.2243
Inject*Sequence(Study)	2	138	12.22	<.0001

Abbreviations: Num DF=numerator degrees of freedom, Den DF=denominator degrees of freedom, F=F test, P=P-value

Table 4: Average VAS Pain in Each Study Group

			Pain VAS					
Sequence	Injection	Order	n	Estimate	SE	95% CI		P
articaine vs polocaine subjects								
Artic Polo	Artic	1st	12	16.44	3.17	10.09	22.79	
	Polo	2nd		17.65	3.17	11.30	23.99	
	Artic-Polo			–1.21	2.04	-5.23	2.82	0.5540
Polo Artic	Artic	2nd	11	20.33	3.31	13.70	26.96	
	Polo	1st		16.81	3.31	10.18	23.44	
	Artic-Polo			+3.52	2.12	-0.67	7.71	0.0989
lidocaine vs polocaine subjects								
Lido Polo	Lido	1st	13	12.64	3.04	6.55	18.74	
	Polo	2nd		19.43	3.04	13.33	25.53	
	Lido-Polo			–6.79	1.95	-10.64	-2.93	0.0007
Polo Lido	Lido	2nd	12	18.50	3.17	12.15	24.85	
	Polo	1st		12.13	3.17	5.78	18.47	
	Lido-Polo			+6.38	2.03	2.37	10.38	0.0020

Abbreviations: Artic=articaine, Polo=polocaine, Lido=lidocaine, SE=standard error, CI=confidence interval, P=P-value

Table 5: ANOVA Results of the First Injection

Effect	Num DF	Den DF	F	P-value
Injection	2	44	0.42	0.6578
Rater	1	47	3.78	0.0579
Side	1	44	0.01	0.9162

Abbreviations: Num DF=numerator degrees of freedom, Den DF=denominator degrees of freedom, F=F test, P=P-value

Table 6: Average VAS pain of the First Injection, by Group

	VAS Pain			
Group	Average	SE	95% CI	
Injection				
Artic	16.57	3.04	10.44	22.70
Lido	12.70	2.92	6.83	18.58
Polo	14.40	2.19	9.98	18.82
Rater				
1	14.61	1.59	11.41	17.81
2	14.51	1.59	11.31	17.70
Side				
L	14.40	2.10	10.17	18.62
R	14.72	2.30	10.09	19.35

Abbreviations: Artic=articaine, Polo=polocaine, Lido=lidocaine, SE=standard error, CI=confidence interval

Table 7: alternate ANOVA Results of the First Injection

Source	Num DF	Den DF	F	P-value
Side	1	41	0.12	0.7258
Rater	1	47	3.78	0.0579
Age	1	41	3.19	0.0814
Sex	1	41	1.62	0.2104
Study	1	41	1.96	0.1691
Injection[Study]	2	41	0.05	0.9516

Table 8: ANOVA results of Numbness

Effect	Num DF	Den DF	F	P
Study	1	44	0.02	0.8883
Sequence(Study)	2	44	0.73	0.4862
Injection(Study)	2	43	19.49	<.0001
Side	1	43	0.36	0.5529
Inject*Sequence(Study)	2	43	0.87	0.4274

Abbreviations: Num DF=numerator degrees of freedom, Den DF=denominator degrees of freedom, F=F test, P=P-value

Table 9: Average Duration for all Study Groups

			Duration (minutes)					
Sequence	Injection	Order	n	Estimate	SE	95% CI		P
articaine vs polocaine subjects								
Artic Polo	Artic	1st	12	162.43	15.32	131.98	192.87	
	Polo	2nd		87.91	15.32	57.46	118.35	
	Artic-Polo			74.52	20.48	33.22	115.82	0.0007
Polo Artic	Artic	2nd	11	137.45	15.98	105.68	169.21	
	Polo	1st		86.19	15.98	54.42	117.95	
	Artic-Polo			51.26	21.34	8.23	94.29	0.0207
lidocaine vs polocaine subjects								
Lido Polo	Lido	1st	13	137.85	14.70	108.63	167.07	
	Polo	2nd		88.15	14.70	58.93	117.37	
	Lido-Polo			49.70	19.62	10.13	89.28	0.0150
Polo Lido	Lido	2nd	12	167.00	15.29	136.60	197.40	
	Polo	1st		87.42	15.29	57.02	117.82	
	Lido-Polo			79.58	20.41	38.43	120.74	0.0003

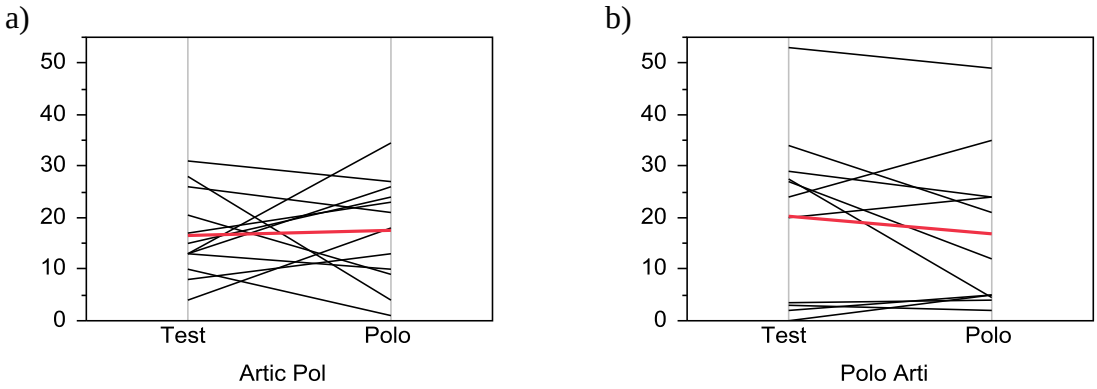
Abbreviations: Artic=articaine, Polo=polocaine, Lido=lidocaine, SE=standard error, CI=confidence interval, P=P-value

Table 10: Average Duration for the Injection Groups

	Duration (minutes)				
Injection	Estimate	SE	95% CI		P
	articaine vs polocaine subjects				
Artic	149.94	11.06	127.96	171.92	
Polo	87.05	11.06	65.06	109.03	
	62.89	14.76	33.12	92.66	0.0001
	lidocaine vs polocaine subjects				
Lido	152.43	10.61	131.34	173.51	
Polo	87.78	10.61	66.70	108.86	
	64.64	14.16	36.09	93.19	<.0001

Figure 1: Individual VAS Pain Ratings in the Two Groups of Subjects

Articaine Study Subjects



Lidocaine Study Subjects

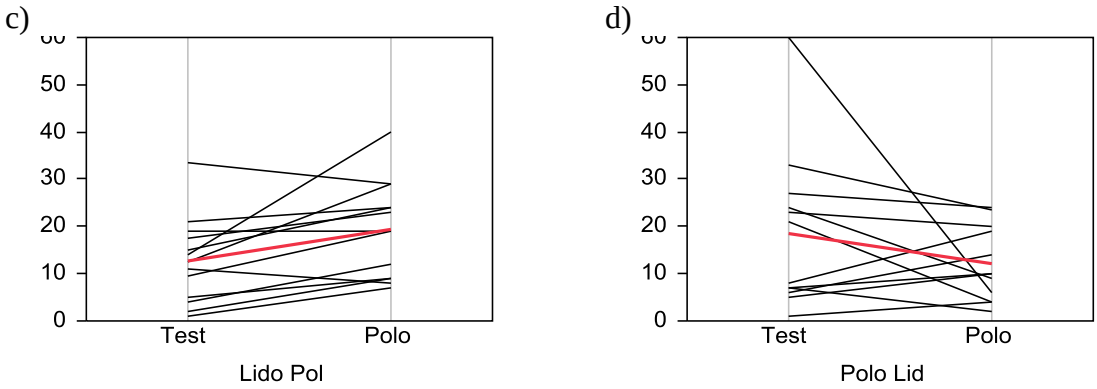
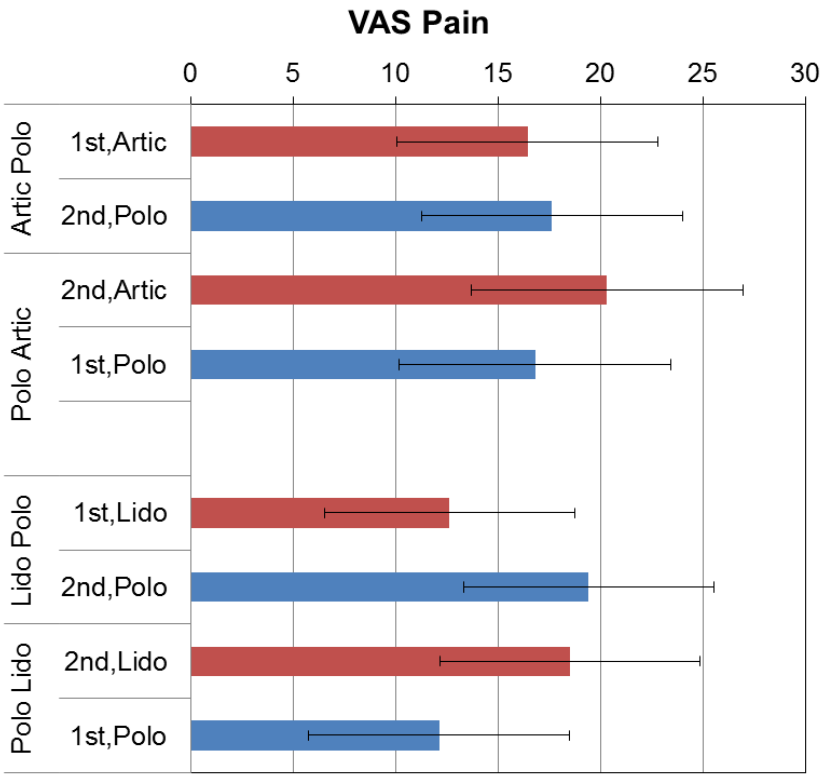


Figure 2: Average VAS Pain in Each Study Group



Comparison of Intraoral Injection Pain from Plain Polocaine versus Epinephrine-Containing Articaine Local Anesthetic Solutions

Health History Form

Name:_____ Contact number:_____ Date of Birth:_____

Are you presently in good general health? ☐ yes ☐ no

If no, please explain:_____

Are you under the care of a physician? ☐ yes ☐ no

If no, please explain:_____

Have you been admitted to the hospital? ☐ yes ☐ no

If yes, please explain:_____

Have you had any surgeries? ☐ yes ☐ no

If yes, please explain:_____

Do you have any heart problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any breathing problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any blood related problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any head, ear, eye, nose, or throat problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any digestive problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any endocrine problems (such diabetes, thyroid, etc)? ☐ yes ☐ no

If yes, please explain:_____

Do you have any nervous system problems (stroke, epilepsy, etc)? ☐ yes ☐ no

If yes, please explain:_____

Do you have any psychiatric problems? ☐ yes ☐ no

If yes, please explain:_____

Do you have any other health concerns? ☐ yes ☐ no

If yes, please explain:_____

For women only – are you currently nursing/pregnant? ☐ yes ☐ no

Family History – cancer, arthritis, neurologic, heart disease, hypertension, anesthesia complications?

_____

_____

Social History – smoking/tobacco use, alcoholic beverages, and/or recreational drugs?

_____

_____

Allergies – Food or drug?

_____

_____

Medications?

_____

_____

Have you taken any analgesics within the past 72 hours?

_____

_____

Have you ever had complications from local anesthetics (numbing medication) in the past?

_____

_____

Comparison of Injection Discomfort and Anesthetic Duration of Plain Polocaine versus Epinephrine containing Articaine and Lidocaine

Dental Resident (Dana Doan, DDS) Script for Study Participation:

You are being asked to participate in a study for my research project.

The purpose of this study is to determine if there is a difference in the discomfort and anesthetic duration commonly experienced by patients following the injection of plain polocaine versus epinephrine containing articaine or lidocaine.

Immediately after the two local anesthetic administration, you will be asked to record injection discomfort on a continuous 100-mm visual analogue scale (VAS) with endpoints "no pain" and "unbearable pain. You will also be asked to record the times at which soft tissue anesthesia wears off for both sides.

Personal information will be collected concerning your health history and the information will be kept anonymous and secure.

Your participation is voluntary - meaning you may stop or withdraw from the study at any point. Volunteering for this study will not affect or change your grade for the pediatric dentistry rotation.

Your participation will potentially help pediatric dentists reduce patient's discomfort associated with injections.

You will be compensated $20 for your participation after both injections are completed, you have provided the requested feedback on your pain level, and the requested feedback on durations at which the soft tissue anesthesia wears off.

If you choose to participate, read over the Consent Form and sign it after all of your questions have been answered. Also, fill out the Health History Form.

Thank you for your time and participation with this study.

Comparison of Injection Discomfort and Anesthetic Duration of Plain Polocaine versus Epinephrine containing Articaine and Lidocaine

Anesthetic Duration Sheet

Subject # _____

Time of 1st injection: _____ Left/Right

Time soft tissue anesthesia for Left/Right side wears off: _____

Time of 2nd injection: _____ Left/Right

Time soft tissue anesthesia for Left/Right side wears off: _____

VITA

Dana Doan was born in the suburb of Houston, Texas. In 2007, she graduated Summa Cum Laude and received her Bachelor of Science in Biology at The University of Texas at Arlington. She was awarded the Second Scholastic honor and Doctor of Dental Surgery Degree from Texas A&M Health Science Center – Baylor College of Dentistry in 2011. After graduating from dental school, Dr. Dana Doan was accepted into a pediatric dental residency at the Virginia Commonwealth University.

Dr. Dana Doan enjoys cooking, traveling, volunteering in Mission of Mercy Projects, and most of all providing quality specialty care to children at home in Texas. Dana plans on working in private practice in Houston and surrounding areas upon completion of residency.